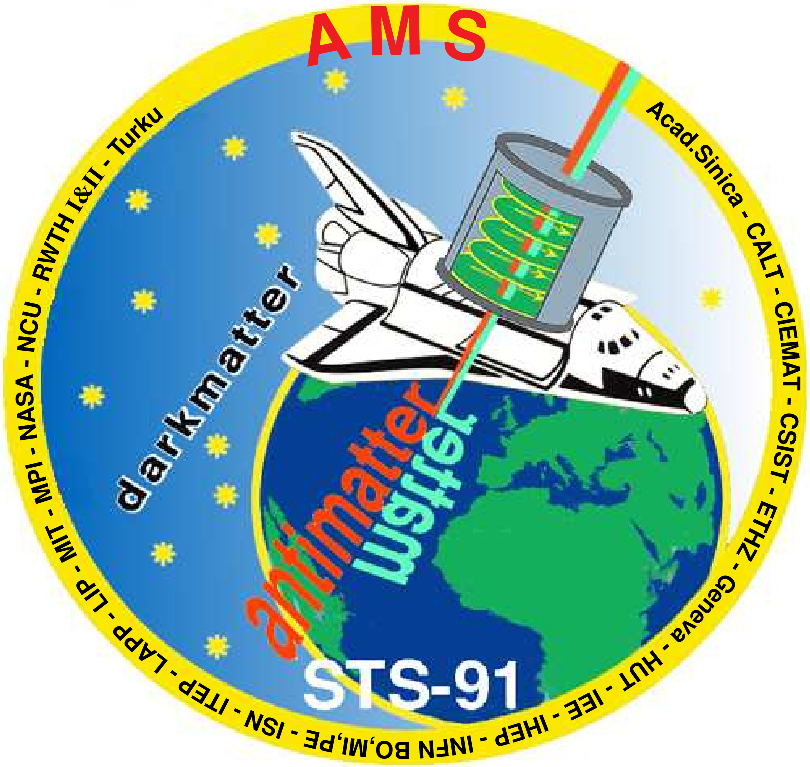
The AMS Microstrips Silicon Tracker



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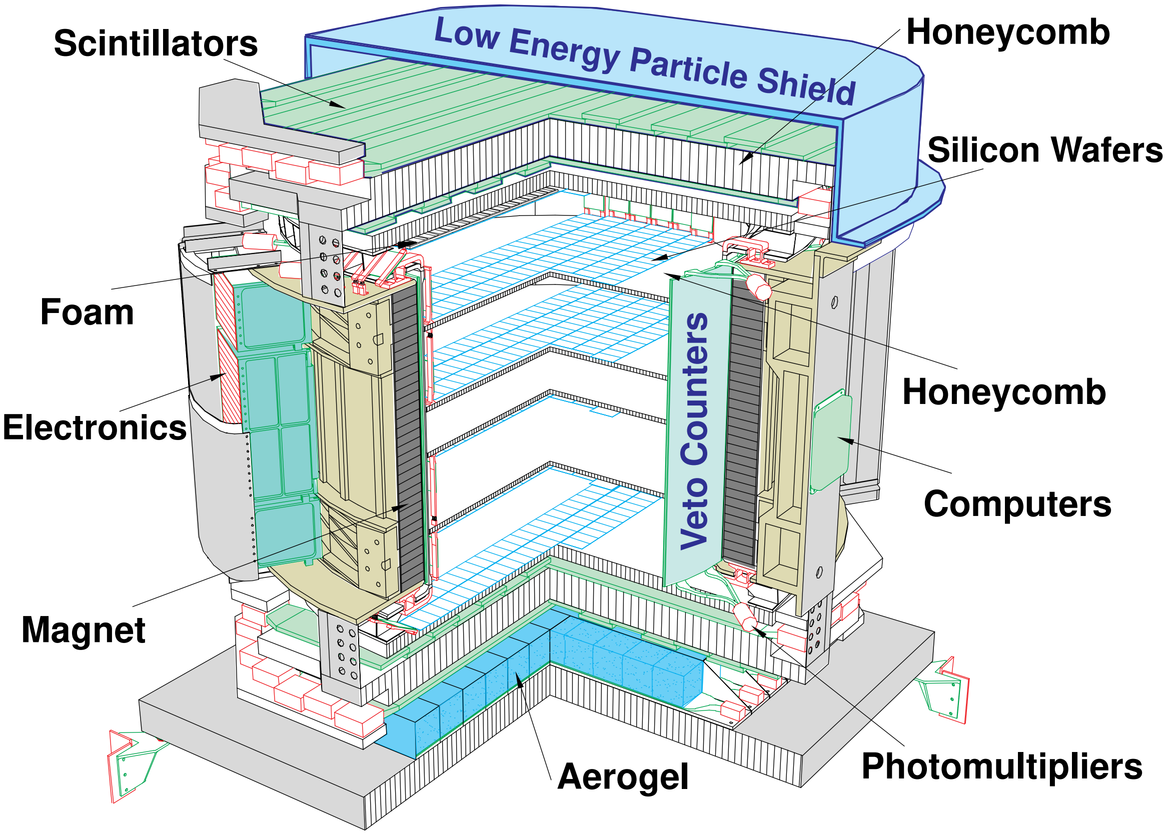
AMS Tracker Collaboration

The AMS Experiment

AMS is a particle physics experiment in space

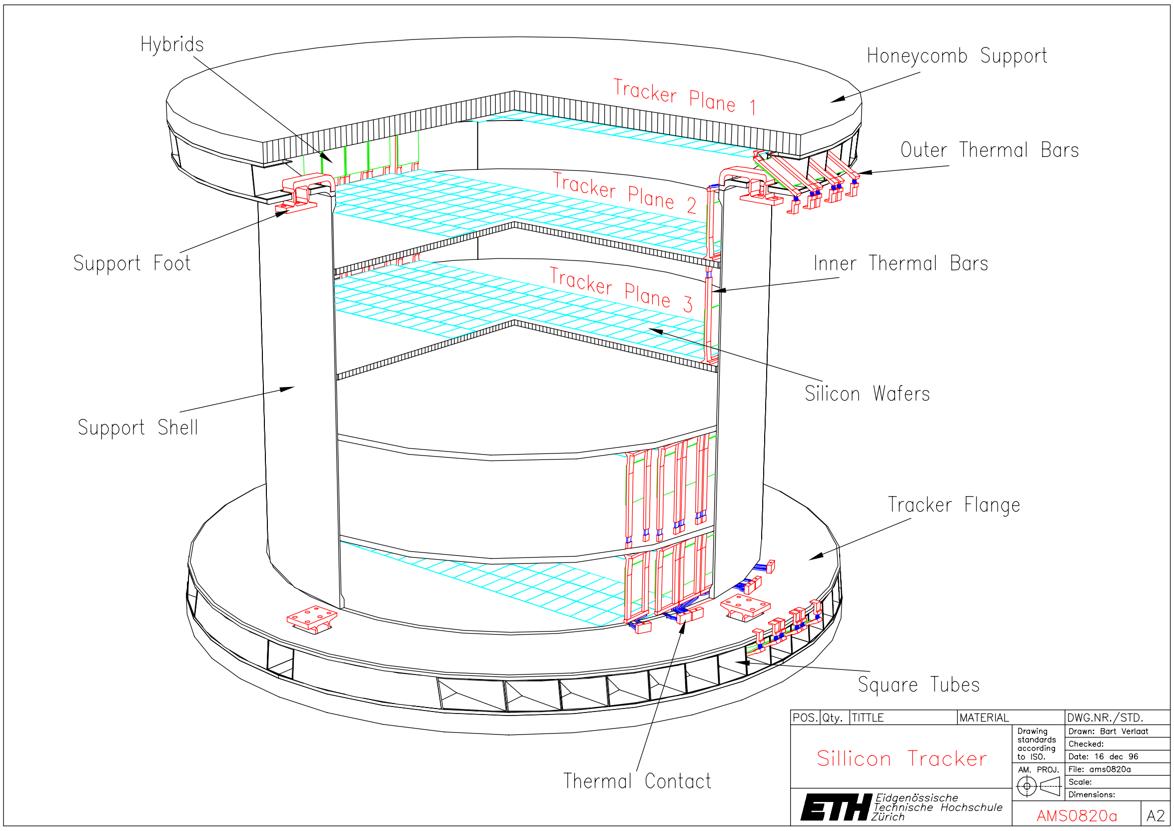
Measurement of Q, p, v and dE/dx of cosmics

- Qualification test flight in 1998 with Space Shuttle
- Installation on ISS scheduled for 2004
- Space operations constraints:
  - Radiation, extreme accelerations and temperature variations
  - Maximum weight $\sim$2 t and power $\sim$2 kW
  - Reliability for 3 years of operation



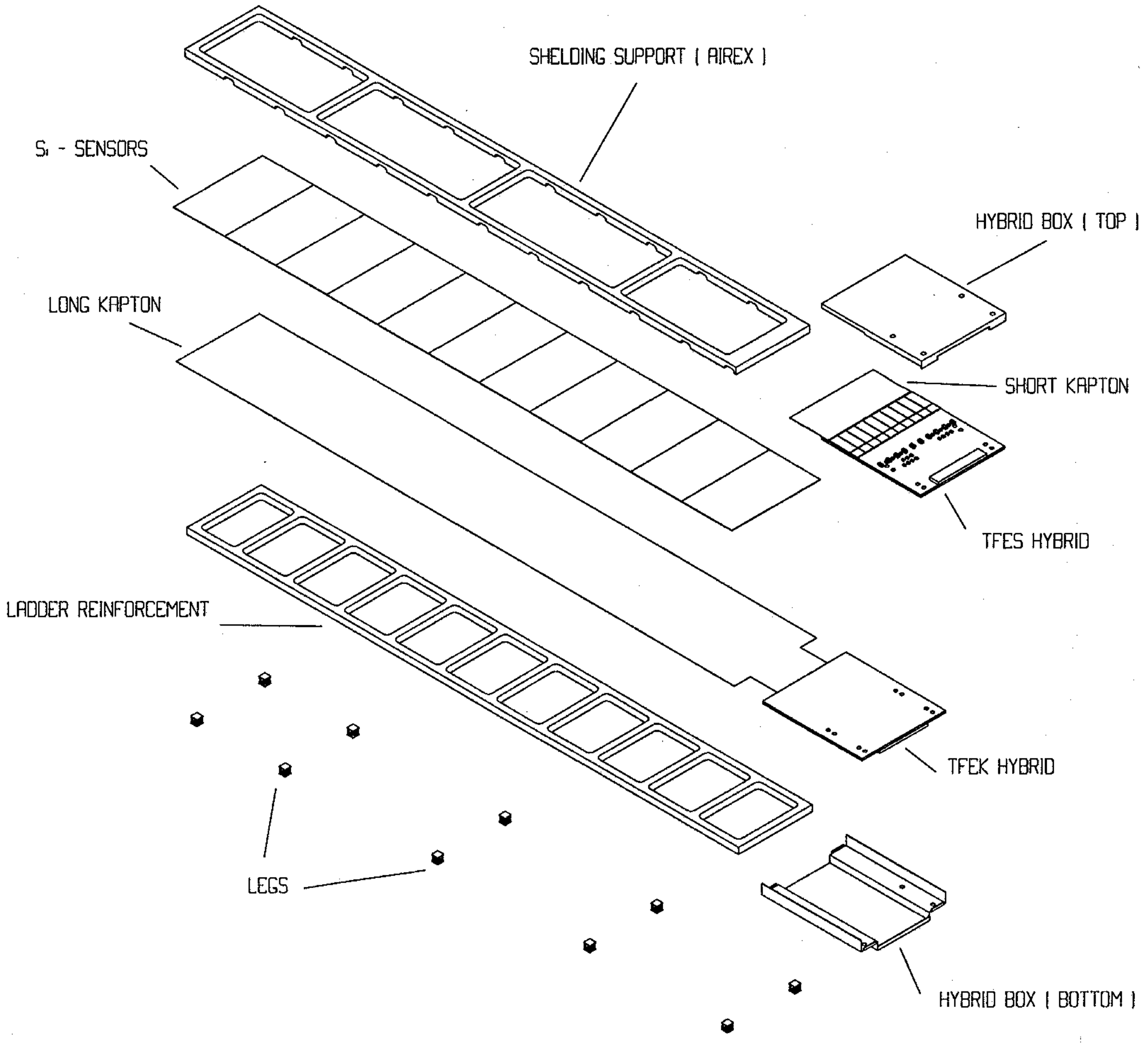
AMS Tracker Characteristics

- Resolution: 10μm bending, 30μm non-bending plane
- Large dynamic range for dE/dx: 1 to 100 MIP
- AMS01: 2 m^2, 6 layers, 60k channels (57 *ladders*)
- AMS02: 7 m^2, 8 layers, 200k channels (192 *ladders*)
- Ladders mounted on Al+C honeycomb support plane
  - ladder and support: $X_0 = 0.65$% per plane
- Planes supported by a Carbon fiber structure
- Heat evacuated by TPG inserts, k=1700 W/deg m



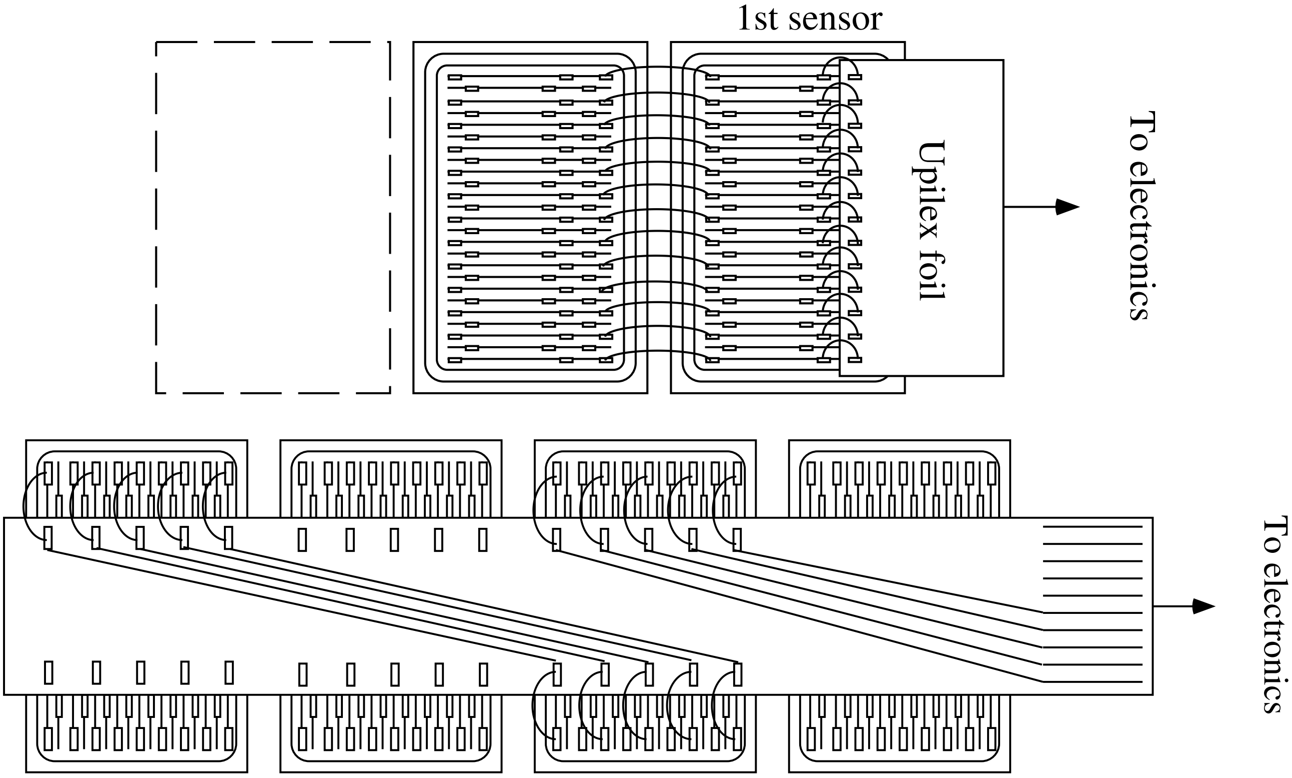
AMS Ladder Construction

- Wafers organised in long *ladders* (7 to 15 per ladder)
- Ladder rigidity provided by sandwich of AIREX foam (5 mm) and carbon fiber surface (0.1 mm)
- Thin EMI shielding wrapped around each ladder



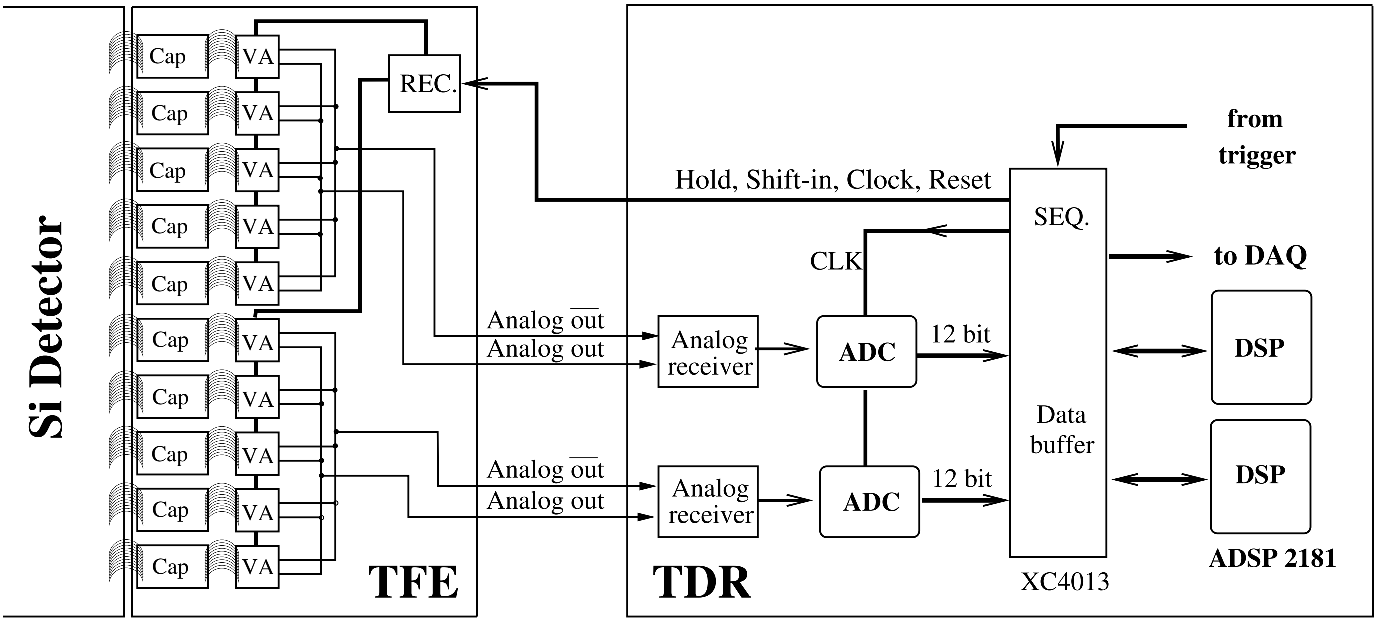
AMS Sensors and Bonding

- Double sided Silicon sensors: $40 \times 72 \times 0.3$mm^3
- Biasing (50 and 100 V) with punch-through and p^+ blocking strips on n-side
- Capacitive coupling with implantation strip pitches of:
  - for p-side: 27.5μm, (110 for readout), 640 channels
  - for n-side: 26.0μm, (208 for readout), 2 × 192 channels
- Connections between the wafers and to the front-end electronics with wire bonds and thin (50μm) flat flexible UPILEX (kapton) micro-circuits



AMS Tracker Electronics

- Front-end electronics based on VA-hdr chip (preamp + memory)
- DSP processors for Tracker Data Reduction (TDR)



Si Detector

Cap

VA

REC.

TFE

Hold, Shift-in, Clock, Reset

from trigger

SEQ.

CLK

to DAQ

Analog $\overline{\text{out}}$

Analog out

Analog receiver

ADC

12 bit

Data buffer

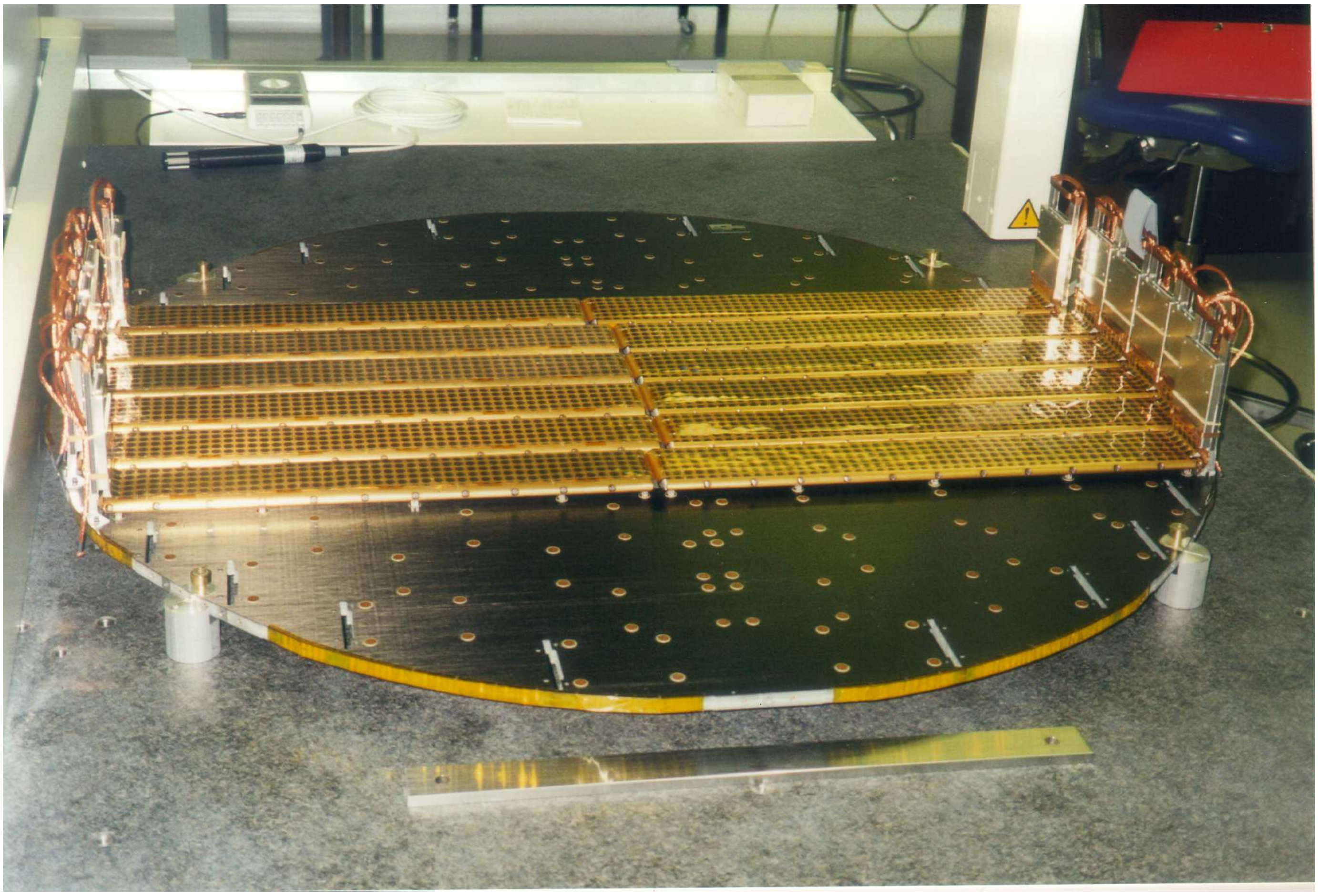
DSP

ADSP 2181

XC4013

TDR

AMS Tracker Plane during Metrology

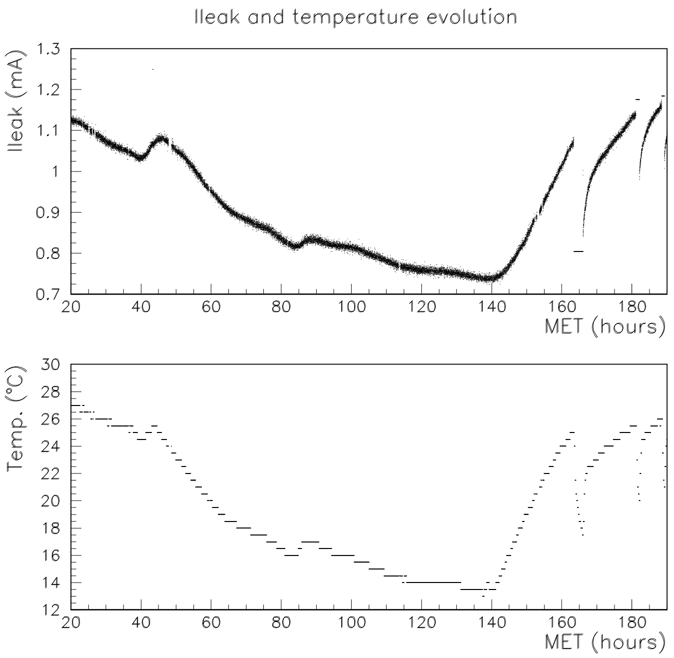


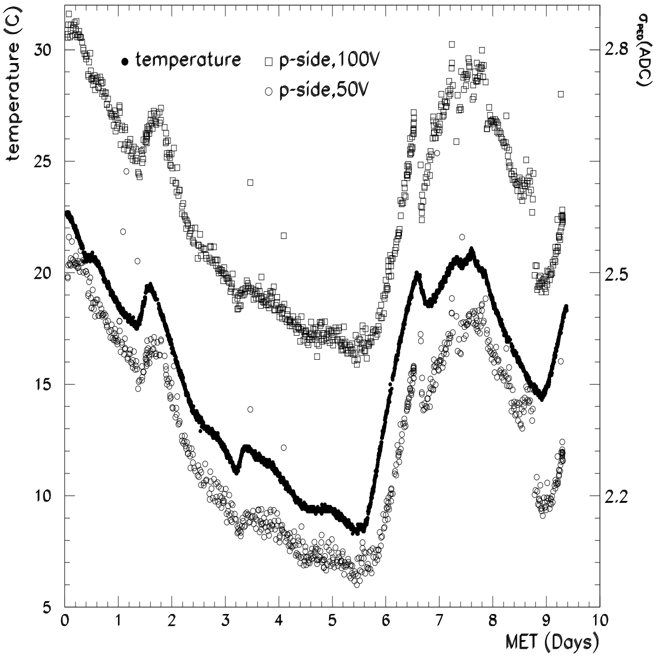
Performance

STS91 flight: June 2-12, 1998

- AMS was secondary payload for test and qualification
- No failure, complete success
- 90 hours of dedicated data taking after MIR undocking
- Test beams at CERN (p) and at GSI (ions)
- Physics results at this conference (V. Choutko)

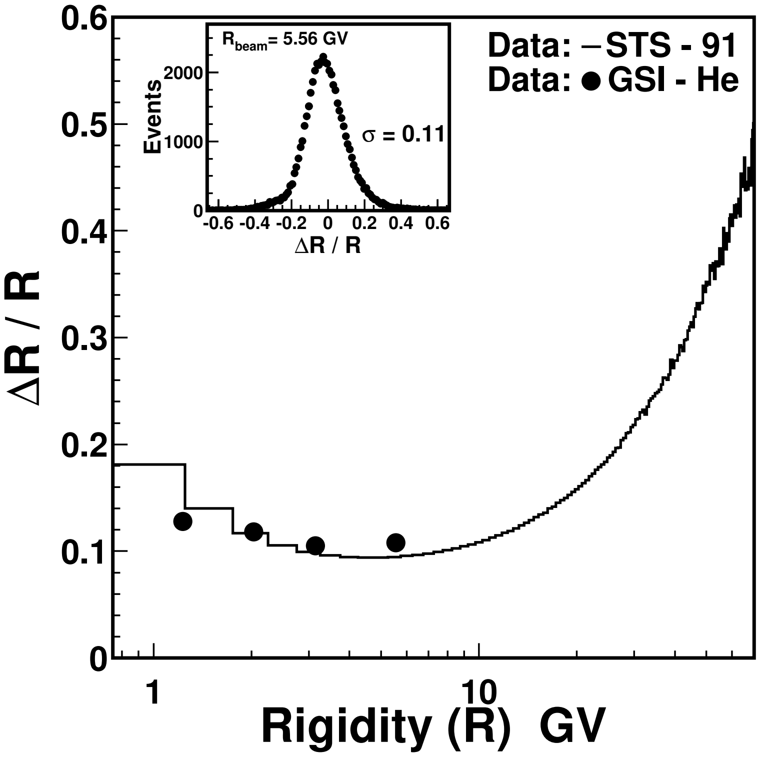
Tracker behaviour with temperature:



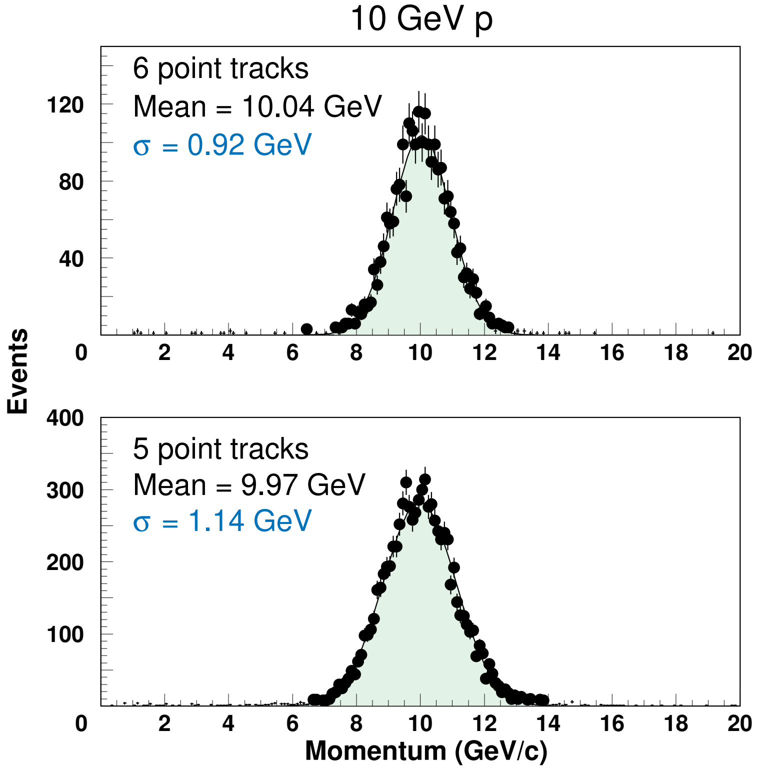


Resolution

Position resolution: 10μm. Magnet: $BL^2 = 0.14$ Tm^2



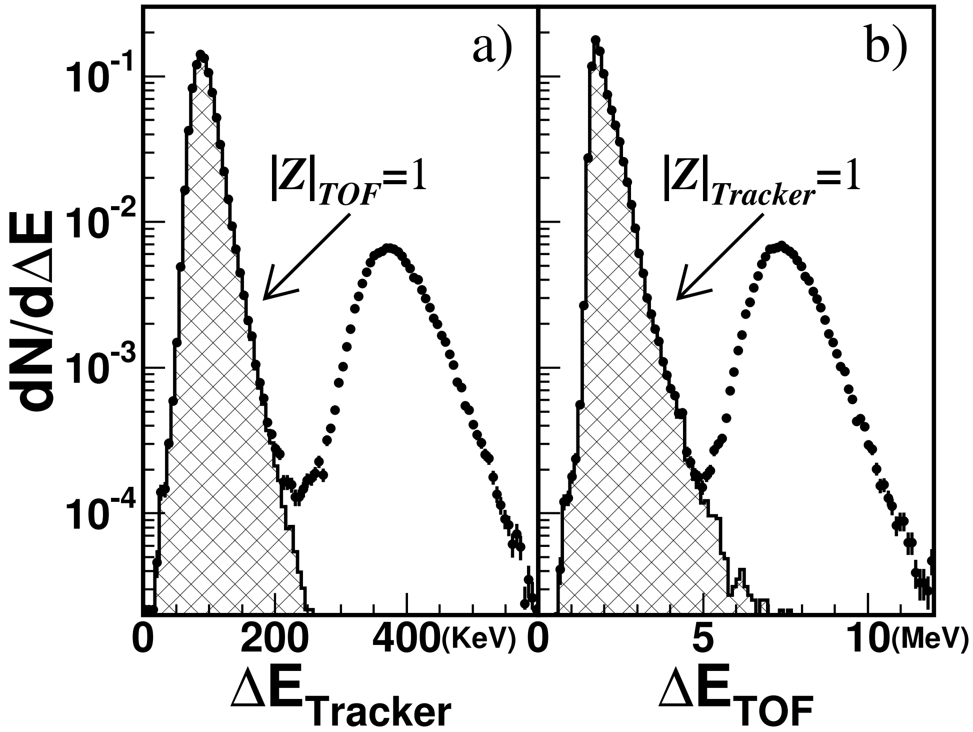
Rigidity resolution for ^{4}He



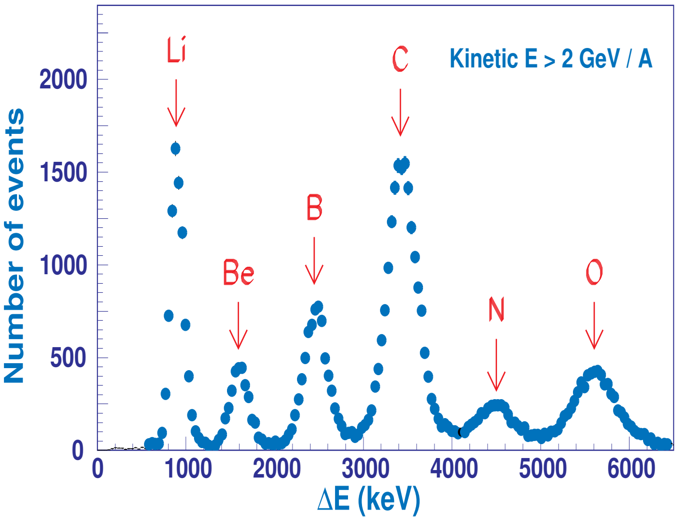
Momentum resolution for protons

Charge identification with dE/dx

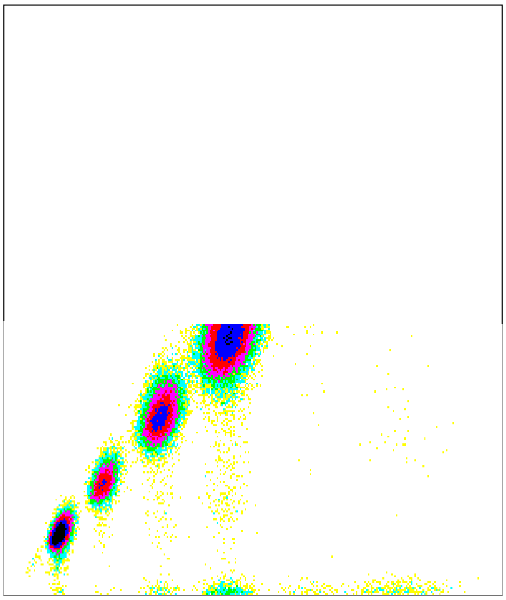
He-p separation (comparison with TOF scintillators)



Ion Identification



Tracker charge identification



Tracker for AMS2

AMS significantly upgraded

Next flight (for ISS) scheduled for early 2004

Tracker improved keeping the same concept:

- Full acceptance coverage (from 2 to 7 m^2, 192 ladders)
- 8 layers instead of 6 for better redundancy
- Better electronics and cooling
- Slight modifications of n-side strips, passivation of Si.